

are the improved types of lenses for lighthouse apparatus recently invented by Mr. Charles A. Stevenson, which he has termed the equiangular refractor, and that of the writer known as the inverse equiangular.

With respect to the smaller classes of lights, there are the new permanent lights burning for some weeks without the attention of a keeper, which are largely used in

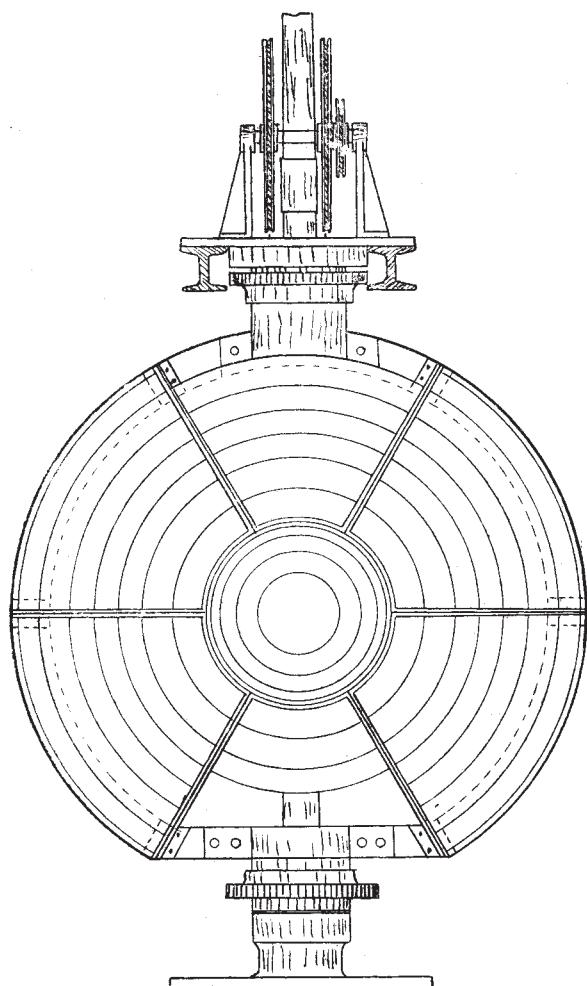


FIG. 4.—Spindle eclipsing apparatus. (Front elevation.)

the French Lighthouse Service. In these lights the upper portion of the wick is carbonised, so that no turning up or down thereof is necessary, and the supply of oil which feeds the lamps is of such a quantity and is so regulated that the lights burn without any attention whatsoever for many days.

J. A. PURVES.

MR. BALFOUR ON SCIENTIFIC RESEARCH.

A SPECIAL festival dinner of friends of King's College, London, was held on Wednesday in last week, with the object of directing attention to the want of new laboratories, especially laboratories for physiological and bacteriological research, and promoting the collection of funds to supply the need. Mr. Balfour presided, and he made excellent use of the occasion by advocating the fuller recognition of the value of scientific research, and increased opportunities for carrying on original investigations. The encouragement of scientific

research is a national responsibility, which has hitherto not been adequately realised either by the State, by public bodies, or by private individuals. Mr. Balfour's remarks, reprinted below, from the *Times*, will serve to remind people of the influence of science upon national progress and prosperity, and may thus lead to a more liberal provision of resources for assisting the advancement of natural knowledge.

We have all of us, probably, been stirred, either in making speeches or in listening to speeches, in recent years on the subject of technical education—a very loose phrase sometimes used, or misused, to mean education in manipulation or dexterity of hand treatment; sometimes, and I think more properly, used to mean that application of science or of the principles of science to industrial life, which we are more and more beginning to recognise is the increasing need of the age in which we live. It has been found easy, and I hope it always will be easy, to enlist popular interest in anything so useful as the application of scientific method to industrial pursuits. It will be all the more easy because of the fact that we have before us in certain countries striking and admirable instances of the success which attends, or may attend, such application of scientific method to industrial pursuits. An appeal for that purpose is an appeal which touches the heart of everybody nearly or remotely connected with the industries on which this nation as a whole lives, and on which it must continue to live if it is to live at all.

I appeal for something not less necessary, though for something perhaps more remote from the ordinary everyday popular educational interest; for I appeal on the present occasion, not so much for anything in the nature of technical instruction or applied science as for aid to carry out that instruction in science itself and those researches in pure science which lie at the base of that instruction which, from the very nature of the case, can only appeal indirectly and remotely to the great mass of mankind. And yet, after all, science is the essential matter that we have got to consider; its applications will come and must come, will come almost of themselves, must come in the course of time; but you cannot have applied science without having science in the first instance, and if you do not cultivate scientific research and scientific education, it will be in vain that you multiply your technical classes, it will be in vain that you labour to erect a great superstructure where your foundations have been so inadequately laid. I feel it the more incumbent upon me to urge upon you the claims and the glories of science pursued for itself from the fact that they cannot directly appeal to the general interest of the mass of mankind. We ought not to wonder, we ought not to criticise, and we ought not to be surprised that, among the great number of persons deeply interested and astonished at, for example, anything so interesting and sensational as wireless telegraphy, few remember the inventions which have made that telegraphy possible; they neither know of nor take interest in the investigations of a Maxwell or the experiments of a Hertz, which, after all, are at the base of the whole thing, without which any such discovery as wireless telegraphy would not have been possible, but who, as discoverers, had fame and recognition among scientific men capable of understanding their work, yet who have not, perhaps, even now that world-wide reputation, that currency in the mouths of men, which fail to inventors much less than themselves, who have properly built their work on the foundations laid for them by others. Yet to my view it is the bounden duty of every great place of University education that they should keep before them not merely the immediately practical needs of technical or other education, but that they should never permit the ideal of University investigation to be for one moment clouded in their eyes, or to lose interest, or cease to be the object of worthy effort and endeavour.

But that great object must increasingly, in my judgment, require the generous and liberal co-operation of all classes of the community, whether they be immediately interested in science, intimately acquainted with scientific details, or whether they be merely part of the general public. Men of science themselves are not always in a position to give that pecuniary aid necessary to establish the modern laboratory and to equip it with modern appliances; and they are right to call upon all those who take any interest in their subjects to aid them with that pecuniary assistance which in some other countries—many other countries—is extended to them by the Government, but which in this country, rightly or wrongly, by an almost immemorial

tradition, has been left chiefly to the energy of private enterprise. King's College will, without question, be one of the great teaching centres of the new London University. It requires at this moment, to enable it to carry out that great function, the assistance of the public to supply it with adequate scientific accommodation, especially, I am informed, in the matter of bacteriological and physiological laboratories and lecture-rooms; and it may be a matter of some consolation to those who take little interest in scientific matters, unless they can see their immediate application, that both bacteriology and physiology have a most immediate and direct bearing upon the life and happiness of mankind. In both branches of study King's College has proved itself rich in teachers of eminence. I am not going to discuss—it would be almost impertinent of me even to touch upon—the enormous interests bound up with the successful prosecution of these two great branches of research; but I may, perhaps, remind you of the enormous practical importance to us, of all people in the world, of some of the more recent researches in bacteriology. Bacteria are a very humble class of organisms, very unjustly abused, as far as I can discover, by ordinary public opinion, in which they suffer, as other classes suffer, by having among them a certain number of black sheep; but for the most part they are not only innocent, but most useful allies to industry, and almost necessary co-operators in some of those great functions which have to be discharged if the health of great cities is to be maintained. But, apart from that, no doubt our chief interest in them lies in the pathogenic members of the group, and we, of all people in the world, are especially interested in treating of those forms of tropical disease which they have produced, since we are engaged in maintaining a number of our population in countries where the diseases born of these bacteria are the greatest scourges. It is, perhaps, to a distinguished professor of King's College more than to any other man in this country that we owe some of the most useful discoveries in these matters. As the last speaker called attention to Mr. Chamberlain's great work in drawing together the bonds of Empire and knitting in closer unity the various elements that make up that Empire, so I may be permitted, in the wholly different subject with which I have to deal to-night, to remind you that he, as Secretary of the Colonies, has done his best to encourage these bacteriological investigations of which I, at all events, entertain such great hopes that science will soon be able to combat, by its discoveries, the inherent difficulties which have hitherto so greatly militated against Europeans in the tropical climates of the world.

WHAT LONDON SHOULD DO.

I do not know that it is necessary for me at greater length to impress upon you the theme which has been committed to my charge; but I confess I cannot conclude without admitting that I think this great city has been somewhat remiss in the support which it has hitherto given to scientific investigation in the commercial metropolis of the world. Technical education, if I may revert for an instant to that subject, has in it almost necessarily some element of competition. We hear it said Germany is doing this, France is doing that, some other country is doing the other, unless you keep abreast of them in your methods of education you will fall behind them in your industrial enterprises. That is a very proper argument; it is a very patriotic argument; it is an argument I myself have used before and shall use again; it is an argument I should think myself justified in using; but I am appealing to you on behalf of a case which has in it none of this element, this inferior and lower element, of competition whatever. Every scientific discovery, wheresoever it be made, be it made in Berlin, Paris, London, New York, Vienna, as soon as it is made is the common property of every man of science. Nations may erect against each other some barrier of tariffs, they may engage in some absurd rivalry animated by I know not what sort of suicidal policy; but men of science wherever they live, to whatever nation they belong, have a cause common to humanity at large, which knows no provincial boundaries, which is not interfered with by any sectional rivalries. To that great common fund of knowledge, the basis after all of your civilisation as it is, the basis after all of the industrial progress you propose to make, I think London should contribute its full share. London takes a well-earned tribute from every discovery made throughout the world for the advancement of civilisation; from all these some section of London gets the benefit. Let those who are dwellers in London feel that they have some obligation to the world at large cor-

responding to the great, the international position we occupy. Let us do what we can as a community to further that investigation into the secrets of nature, that storming of the citadels of natural knowledge in which all civilised men are, and ought to be, co-operators. Let it not be that, while there are great centres of scientific teaching in every other great metropolis, we have allowed ours for one moment to fall behind in the race.

GENERAL A. A. TILLO.

GENERAL A. A. TILLO, Vice-President of the Russian Geographical Society, who died at St. Petersburg on January 11, was the founder of an *exact* physical geography of Russia, based on correct scientific data. He was born in 1839, and received his education in the Constantine Military School, from which he was promoted officer in 1859. He completed next his education by passing through two military academies, artillery and General Staff, and worked for two years at Pulkova in the Geodetic Department of this last academy. In the years 1879-82, in his capacity as educator of one of the Russian Grand-Dukes, he followed lectures on mathematics in different West European universities, as also a full course of Law at the University of Strasburg. He began geographical work as the head of the surveys of the Orenburg region, by publishing a catalogue of latitudes and longitudes determined in that region, followed by a study of the distribution of magnetic elements, and by a description of the levelling made between the Caspian Sea and Lake Aral. His next works were "On the Byelgorod Magnetic Anomaly," "On the Present Condition of the Science of Terrestrial Magnetism," and "On the Yearly Amplitudes of Variations of Level in the Lakes of Russia," "On the Average Altitudes of the Continents in Both Hemispheres." Settling some five-and-twenty years ago at St. Petersburg, he began to work out in a most systematic way the different portions of a general physical geography of Russia. The surfaces of different parts of the empire having already been calculated by Strelitzky, General Tillo measured first, with a very great accuracy, the lengths of the rivers of the Russian Empire, their gradients, and the surfaces of their basins, thus correcting many erroneous statements of his predecessors. Then, he worked for years in collecting all documents relative to the altitudes of European Russia, and finally published in 1889 his most remarkable hypsometric map of European Russia, on a scale of 40 miles to an inch, followed seven years later by the same improved map on a still larger scale (27 miles to an inch), in four sheets. This map, by showing the existence of three great depressions amidst the swelling of Middle Russia, completely altered the hitherto current conceptions as to the orography of European Russia. His next work was a most elaborate atlas of isobars in Russia and Asia altogether, and it was followed by still more elaborate works on the distribution of magnetic elements on the surface of the earth, "Variation séculaire et épémérides du Magnétisme terrestre," "Loi de la Distribution du Magnétisme moyen à la Surface du Globe," "Atlas des Isanomales et des Variations séculaires," and "Tables fondamentales du Magnétisme terrestre," which won for Tillo a wide European reputation. His smaller contributions to the publications of the Russian Geographical Society were countless. He was a member of both the St. Petersburg and the Paris Academies of Sciences. His extreme modesty and willingness to undertake any amount of calculations to work out the results of observations made by explorers in Asia, made of him one of the most sympathetic figures in the Russian Geographical Society, in which he presided over the Physical Geography Section. A pamphlet containing an obituary notice of General Tillo, and a full list of his works, has just been published by this Society.